Catchment Monitoring for Scaling and Assimilation of Soil Moisture and Streamflow

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Abstract: The aim of this research is to provide meaningful estimates of the spatial distribution and temporal variation of soil moisture content in the root zone through a combination of modelling and observations using data assimilation. The field work component includes the validation of remotely sensed near-surface soil moisture data (25km $\times$ 25km spatial resolution) from the Advanced Microwave Scanning Radiometer for the Earth observing system (AMSR-E), collection of near-surface soil moisture and stream flow data for assimilation, and monitoring of point soil moisture profiles for validation purposes. The monitoring includes 26 soil moisture profile monitoring sites, 9 stream gauges, 5 weather stations, and numerous rain gauges throughout the 7 000km^2 Goulburn River catchment in New South Wales, Australia. Monitoring is concentrated in the northern more open cropping and grazing half of the catchment, with less intensive monitoring in the southern more forested southern half of the catchment. This study has three major components. The *scaling* component of this research is developing techniques for downscaling the large-scale satellite measurements to the point-scale, while the *soil moisture assimilation* component is investigating the best way to use both the large- and point- scale near-surface soil moisture data to better estimate the root zone soil moisture content in areas of low vegetation. The *streamflow assimilation* component is investigating how streamflow data may be used to better estimate the root zone soil moisture content in areas of dense vegetation (where remote sensing data is not available), and how it may be used to further constrain soil moisture estimates in areas of low vegetation.

Keywords: *Soil moisture; Streamflow; Data assimilation; Remote Sensing; Scaling*

1. INTRODUCTION

Soil moisture is a significant factor in climatic and hydrologic behaviour. It influences the infiltration capacity of the soils (and therefore runoff), water availability for evapotranspiration and thus cloud formation due to latent and sensible heat flux (e.g. Friedrich and Mölders, 2000), and it plays an important role in land surface modelling (e.g. Jackson et al., 1982) for global climate prediction (e.g. Koster and Suarez, 1995). It is therefore important to understand and model the processes that drive temporal and spatial variability in soil moisture.

Satellite remote sensing offers some potential to retrieve large scale near surface soil moisture data on a sufficiently regular temporal basis (i.e. 1 to 2 days). However, data from passive microwave sensors is not ideally suited for catchment scale hydrological applications, due to its coarse spatial resolution. Additionally, passive microwave remote sensing only provides information on soil moisture content in the first few centimetres of soil (Njoku, 1994). Finally, information on soil moisture content can only be retrieved for areas with low vegetation biomass (e.g. Jackson et al., 1982; Schmugge et al., 2002). Thus it is important that methods be developed for: i) the downscaling of these low spatial resolution measurements; ii) estimation of the deeper root zone soil moisture content from these shallow surface measurements; and iii) estimation of soil moisture content under areas of dense vegetation where remotely sensed soil moisture data is not available.

Several approaches to determine soil moisture content at a range of spatial and temporal scales will be undertaken as part of the project "Scaling and Assimilation of Soil Moisture and Streamflow" (SASMAS), jointly undertaken by the Universities of Melbourne and Newcastle (see also http://www.civenv.unimelb.edu.au/~jwalker/data/sasmas). This paper describes the field data collection program underway in the Goulburn River catchment (Figure 1) near Newcastle, New South Wales, Australia, for the purpose of validating these approaches. This data will be key to the development of algorithms for downscaling the low resolution satellite observations to sub-farm scale, assimilation of remotely sensed near-surface soil moisture for retrieval of the soil moisture profile, and assimilation of streamflow observations for soil moisture retrieval. The study region will also be used to verify the remotely sensed soil moisture data from the Advanced Microwave Scanning Radiometer for the Earth observing system (AMSR-E).